

Claims

1. A hydraulic actuator comprising a reciprocal hydraulic piston, a hydraulic cylinder and a hydraulic pressure source wherein said hydraulic piston has a larger area exposed to pressure on the side of the control chamber than on the side of oil supply chamber of said hydraulic cylinder, wherein

said hydraulic piston has, in its outer peripheral part, a slot connecting said oil supply chamber side with the control chamber side in the direction of shaft and the cross sectional area of the slot in the direction of said shaft changes according to the displacement of the hydraulic piston in the direction of its shaft, and said control chamber has a hydraulic pressure release control valve.

2. The hydraulic actuator according to claim 1, wherein said hydraulic pressure release control valve is a solenoid controlled pilot operated valve.

3. The hydraulic actuator according to claim 1 wherein said hydraulic pressure release control valve is an electro-hydraulic proportional control valve.

4. A variable valve system of internal combustion engine for opening and closing a suction valve for aspirating gas into the internal combustion engine and an exhaust valve for exhausting combustion gas by a hydraulic actuator through a coupling and a spring for the valve, and for variably controlling the opening and closing timing and the opening and closing time of said valve, wherein

the hydraulic actuator according to said claim 1 or claim 2 is used as said hydraulic actuator, and said valve is variably controlled by controlling said hydraulic pressure release control valve.

5. A variable valve system of internal combustion engine for opening and closing a suction valve for aspirating gas into the internal combustion engine and an exhaust valve for exhausting combustion gas by a hydraulic actuator through a coupling and a spring for the valve, and for variably controlling the opening and closing timing, the opening and closing time and the lift of said valve, wherein

the hydraulic actuator according to said claim 3 is used as said hydraulic actuator, and said valve is variably controlled by controlling said hydraulic pressure release control valve.

6. The variable valve system for internal combustion engine according to claim 4 or

claim 5, wherein the cross sectional area of said slot in the direction of the shaft gradually decreases as said hydraulic piston displaces in the closing direction of said valve.

7. The variable valve system for internal combustion engine according to claim 6, wherein the structure of the gradually decreasing the cross sectional area of said slot consists of gradually changing the groove depth of the slot while the groove width is kept constant.

8. The control method of the variable valve system according to claim 4 or claim 5, wherein, for the closing operation of said valve, said hydraulic pressure release control valve is switched from OPEN to CLOSE followed by at least another operation of opening and closing the hydraulic pressure release control valve to close said valve.